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# OPERATING EXPERIENCE WEEKLY SUMMARY

## Office of Nuclear and Facility Safety

**December 11 - December 17, 1998**

**Summary 98-50**

# Operating Experience Weekly Summary 98-50

*December 11 through December 17, 1998*

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# EVENTS

## 1. ELECTRICAL ARC NEAR-MISS AT OFF-SITE FACILITY

On December 2, 1998, at the Rocky Flats Environmental Technology Site Broomfield Warehouse, an electrical engineer accidentally contacted an inadequately wrapped bolted 480-V cable connection with a clamp-on ammeter, causing an electrical arc and a blown fuse in the power distribution panel. The engineer was measuring current flow in surrounding components and was attempting to attach the ammeter when he contacted the cable connection and caused it to contact a metal wireway. When the ammeter contacted the bolted connection he heard a loud “pop” and saw a flash. Warehouse personnel secured the system power and notified the manager of the event. Broomfield Warehouse is an off-site facility where contractor personnel are operating and testing a plutonium packaging system mock-up that will eventually be installed and used on-site. Investigators determined that because the warehouse is off-site and is not a DOE facility, no one implemented the necessary work control programs or safety measures. Although the engineer was not injured, no safety measures were in place to protect him from a fatal electrical shock or a severe flash burn. (ORPS Report RFO--KHLL-371OPS-1998-0085)

Investigators determined that the bolted cable connection was inadequately taped because no tape was covering one area of the splice. Electrical codes require three layers of rubber tape and a layer of electrical tape to cover bolted cable connections. Investigators inspected the area and found a small burn on a wireway and damaged tape on part of the bolted cable connection. Warehouse personnel retaped the connection to conform to electrical codes and restored system power.

The facility manager held a fact-finding meeting for this event. Meeting attendees learned that the warehouse personnel, including the project lead, did not understand what work control requirements were necessary when performing work at off-site facilities. They also learned that no one had (1) implemented a lockout/tagout program or installed any lockouts or tagouts for the work, (2) obtained an energized electrical work permit to work on or near energized components, and (3) used electrical safety equipment. Meeting attendees learned that the engineer was not properly trained to perform energized electrical work and that no one assigned craft personnel or electricians to perform the work. They also learned the following.

- No one had developed a documented work package to translate the job mission into work and set safety expectations.
- No one had performed a hazard assessment for the job.
- No one had developed or implemented work controls for the job and no one established adequate controls for the warehouse.
- No one had communicated lessons learned from similar electrical accidents to employees.

The facility manager directed personnel to (1) determine what work controls and safety programs apply, (2) strictly limit warehouse operations to those that are bounded by a test plan until the work controls and safety programs determination is made, (3) brief warehouse operations personnel on these work limitations, (4) perform a job hazards analysis to ensure that the test plan includes all necessary controls and safety measures, and (5) brief warehouse operations personnel on the work control and safety programs when the programs are determined and implemented.

NFS has reported similar events involving accidents while working near energized equipment. Following are some examples.

- Weekly Summaries 98-36 and 98-21 reported that an electrician at the Kansas City Plant received second- and third-degree flash burns from an electrical arc blast while cleaning a 13.8-kV switch at an outdoor substation. The electrician's burns required skin grafts to his right arm and left hand. A Type B Accident Investigation Board identified the root cause of the event as lack of effective work integration and failure to responsibly implement the high-voltage work control process. (*Type B Accident Investigation Board Report on the May 24, 1998, Electrical Arc Blast at the Kansas City Plant*, July 1998; and ORPS Report ALO-KC-AS-KCP-1998-0010)

- Weekly Summary 98-35 reported that a subcontractor electrician at the Rocky Flats Environmental Technology Site Plutonium Processing and Handling Facility observed an electrical arc from a primary-phase winding connection on an energized 480-V, three-phase transformer to a ground-strap while he was working on it. The arc left burn marks on the electrician's protective glasses, but he was not injured. Investigators believe that material the electrician was removing from the area accidentally contacted a ground-wire lug, causing the arc. (ORPS Report RFO--KHLL-371OPS-1998-0065)

- Weekly Summary 98-29 reported that an electrician at the Hanford Site N-Reactor observed an electrical arc and fireball while disconnecting circuit leads from a 480-V motor control center. The fireball resulted after a bare ground-wire came in contact with the exposed, energized feeder bus in the motor control center. (ORPS Report RL--BHI-NREACTOR-1998-0020)

- Weekly Summaries 98-23 and 97-44 reported that two subcontractor electrical workers at Fermi National Accelerator Laboratory received flash burns from an electrical arc blast when a metal cover contacted an energized bus bar as they attempted to connect a neutral cable for a temporary feed from a 480-V motor control center panel. A Type B Accident Investigation Team identified the following root causes for the event: (1) the electricians did not understand that there were energized components behind the bus bar cover and (2) the Laboratory failed to ensure that an integrated safety management system was implemented for electrical work. (*Type B Accident Investigation Board Report on the October 22, 1997, Electrical Arc Blast at Building F-Zero, Fermi National Accelerator Laboratory, Batavia, Illinois*, November 1997; and ORPS Report CH-BA-FNAL-FERMILAB-1997-000 4)

In the Broomfield warehouse event, warehouse controls, documentation, and communication for electrical work were inadequate to satisfy the five core functions of DOE's integrated safety management system: (1) define the scope of work; (2) identify and analyze the work hazards; (3) develop and implement hazard controls; (4) perform work within controls; and (5) provide feedback on the adequacy of controls and on continuous improvement in defining and planning work. Because line management responsibilities for off-site work and safety were not clearly defined, the job mission was not translated into safe work practices, safety expectations were not set, and trained and experienced personnel were not appropriately assigned to the facility.

These events underscore the importance of an integrated approach to safety that stresses clear goals and policies, individual and management accountability and ownership, implementation of requirements and procedures, and thorough and systematic management oversight. The responsibility for ensuring adequate planning and control of work activities resides with line management. Managers should ensure that work control processes are followed and facility practices are enforced. Safety and health hazard analyses must be included in the work control process to help prevent worker injury. The hazard analysis process should include provisions for lockout/tagouts, job-specific walk-downs, integration of work activities, and personal protective equipment. Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with high-voltage electrical activities.

Personnel at DOE facilities should have a continually questioning attitude toward safety issues. Each individual is ultimately responsible for complying with rules to ensure personal safety. Facility managers should communicate the idea that safety is of prime importance and that all personnel must be committed to excellence and professionalism.

Facility managers, work planners, and crafts personnel should review the following references, which provide guidance and good practices for planning electrical work.

- DOE O 4330.4B, *Maintenance Management Program,* chapter 6, provides guidance for preparing and using procedures and other work-related documents that contain appropriate work directions. Section 6.2 states that deficient procedures and failure to follow procedures are major contributors to many significant and undesirable events.

- 29 CFR 1910.333, *Selection and Use of Work Practices*, states: “When any employee is exposed to contact with parts of fixed electric equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out or tagged out.” It also states: “Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized.” It also requires a qualified person to test the equipment to verify that all circuit elements and equipment parts are de-energized.

- 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* provide guidance on the implementation of effective lockout/tagout programs. They both state that the primary purpose of a lockout/tagout program is to protect personnel from injury and protect equipment from damage. 29 CFR 1910, sub-part S, "Electrical," describes work practices to be employed to prevent injuries when work is performed near or on equipment or circuits that are, or may be, energized.

- DOE/ID-10600, *Electrical Safety Guidelines*, prescribes electrical safety standards for DOE field offices and facilities. It includes information on training and qualifications, work practices, protective equipment, insulated tools, and recognition of electrical hazards. Section 2.13.1.3 states that when circuits and equipment are worked on they must be disconnected from all electrical energy sources. These guidelines are intended to protect personnel from electrical shock and potential fatalities.

- DOE-HDBK-1092-98, *Electrical Safety*, contains explanatory material in support of OSHA regulations and nationally recognized electrical safety-related standards. It addresses electrical safety for enclosed electrical and electronic equipment and discusses the latest editions of 29 CFR 1910 and 29 CFR 1926 and National Fire Protection Association Standard 70E, “National Electrical Code.”

NFS encourages managers to incorporate lessons learned from other organizations and to take these lessons into account in their programs. Managers, supervisors, and operators should review operating experience information and implement it as the standard suggests. Lessons learned are valuable only if the information they communicate is used.

- DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, was designed to promote consistency and compatibility across programs. Both lessons learned and program managers should review the standard and incorporate applicable elements into their site programs. Managers, supervisors, and operators should review lessons learned documents for applicability, and the information should be used to improve operations.

- DOE-STD-1010-92, *Guide to Good Practices for Incorporating Operating Experiences*, states: "The use of experience gained should provide a positive method that a facility can use to improve their operations, making them efficient, cost-effective, and safe to the employees, the public, and the environment." Managers, supervisors, and operators should review operating experience information and implement it as the standard suggests. Lessons learned are valuable only if the information they communicate is used.

Integrated safety management information can be found at the website http://tis-nt.eh.doe.gov/ism. DOE technical standards can be found at the website http://www.doe.gov/html/techstds/standard/standard.html. Additional information on electrical events can be found in article 2.

**KEYWORDS:** electrical safety, hazard analysis, near-miss, work planning

**FUNCTIONAL AREAS:** Electrical Maintenance, Hazards and Barrier Analysis, Work Planning, Industrial Safety

## 2. ELECTRICIAN RECEIVED ELECTRICAL SHOCK WHILE PERFORMING MAINTENANCE ACTIVITIES

On December 4, 1998, at the Rocky Flats Environmental Technology Site, a construction electrician attaching a light fixture to a wall received an electrical shock when conduit from the light fixture contacted a junction box. Workers in the area stopped work and the electrician was sent to the medical department for an evaluation. Medical personnel determined that the electrician did not experience any harmful effects. Investigators determined that the junction box was powered from another junction box embedded inside the wall and that because of a defect in the facility electrical distribution system there was no ground path between the junction boxes. In addition, an emergency light attached to the outside of the junction box failed. Together, the defect and the failure caused the junction box to be energized to 218.9 V. Unidentified electrical hazards have the potential to cause severe injuries or a fatality. (ORPS Report RFO--KHLL-371OPS-1998-0084)

Facility personnel will investigate the cause of the emergency light failure to determine if it was an isolated failure. The facility manager held a fact-finding meeting on this event and directed facility personnel to perform facility walk-downs to identify junction boxes that are not properly grounded and modify them as needed. He directed facility personnel to ensure that written instructions exist for workers to check for grounding straps before performing work. He also directed facility personnel to prepare and issue a sitewide lessons learned document on this event.

NFS has reported unidentified electrical shock hazards in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-25 reported that a technician at the Los Alamos National Laboratory Materials Science Complex received a mild shock when he cleaned dust from the outside surface of a resistance furnace oven. Investigators determined that the technician completed a 110-V circuit when one of his hands contacted the oven chassis while the other was on another grounded device. An inspector determined that someone had modified the main power cord ground wire, creating an electrical hazard. (ORPS Report ALO-LA-LANL-MATSCCMPLX-1998-0002)

- Weekly Summary 98-04 reported two events in which personnel received electric shocks at the Sandia National Laboratory. On January 16, 1998, a technician received an electrical shock while replacing a test circuit. On January 22, 1998, another technician received an electrical shock while cleaning support fixtures on a Mini-Marx generator. (ORPS Reports ALO-KO-SNL-14000-1998-0001 and ALO-KO-SNL-9000-1998-0002)

- Weekly Summary 96-20 reported that electricians at the Advanced Test Reactor discovered an electrical shock hazard during operation of a 480-V motor control center reset button with the contactor in the NOT TRIPPED position. They determined this situation could result in a short between a load lead on the contactor and the panel front cover, placing the operator at risk of electrical shock. (INEL Lessons Learned No. 96237)

These events demonstrate the importance of multiple engineered barriers to prevent hazardous events such as electrical shocks or discharges. Although human performance (supported by procedures, policies, memoranda, or standing orders) is a standard barrier to preventing electrical shocks and arcs, the probability of prevention can be increased by adding physical barriers. These events also illustrate the problems that can be encountered while working near energized electrical systems. Workers must be trained in and made aware of electrical hazards.

Managers and supervisors in charge of job performance should ensure that hazards are identified and corrected. DOE facility managers should ensure that personnel understand the basics of work control practices and safety and health hazard analyses. Personnel in charge of system design changes should ensure that facility documentation, including procedures and drawings, is updated and accurate.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing.

- DOE/ID-10600, *Electrical Safety Guidelines*, prescribes electrical safety standards for DOE field offices and facilities. Included in the guidelines is information on training and qualifications, work practices, protective equipment, insulated tools, and recognition of electrical hazards. In July 1996, prompted by the recurrence of incidents across the DOE complex involving actual or potential electrical shock incidents, the Office of Defense Programs issued a safety information letter, SIL 96-03, "Electric Shock." This publication describes nine representative events chosen to illustrate the hazards of unexpected exposure to electricity. DOE facility managers, facility representatives, and contractor facility managers should continue to emphasize the dangers and life-threatening characteristics of uncontrolled electricity.

- DOE-STD-1073-93–Pt.1 and –Pt.2*, Guide for Operational Configuration Management Programs, Including the Adjunct Programs of Design Reconstitution and Material Condition and Aging Management*, provides guidelines and good practices for an operational configuration management program including change control and document control.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over hazards associated with a job. Barriers may be physical barriers, procedural or administrative barriers, or human action. The reliability of barriers is important in preventing undesirable events such as shocks. The reliability of a barrier is determined by its ability to resist failure. Barriers can be imposed in parallel to provide defense-in-depth and to increase the margin of safety. The *Hazard and Barrier Analysis Guide* provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards.

A copy of the *Hazard and Barrier Analysis Guide* is available by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. A copy can also be found at http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf. Additional information on electrical events can be found in article 1.

**KEYWORDS:** electrical shock, electrical hazard

**FUNCTIONAL AREAS:** Industrial Safety, Configuration Control, Hazards and Barrier Analysis

## 3. HAZARD IDENTIFICATION GOOD PRACTICE AT OAK RIDGE

This week OEAF engineers identified a good practice involving hazard identification programs during decommissioning activities. On December 8, 1998, at the Oak Ridge National Laboratory East Tennessee Technology Park, facility personnel identified a potential unreviewed safety question when they discovered five tanks (8 feet in diameter and 42 feet long) that could contain chlorine trifluoride or fluorine. Facility personnel determined during a job hazards evaluation that two of 20 tanks may contain chlorine trifluoride and an additional three tanks may contain fluorine. The release of these gases would cause an environment that would be immediately dangerous to life and health. Chlorine trifluoride and fluorine are strong oxidizers and can ignite metal when exposed to unprepared surfaces and are potentially explosive upon contact with organic materials. Facility personnel had previously received lessons learned training to ensure that they make sound decisions and judgements based on reliable information and not just on previously documented facility conditions that are likely to be incomplete or inaccurate. Good facility personnel training and an integrated safety management approach to decommissioning led to quick identification of the hazard and may have prevented a serious event. (ORPS Report ORO--BNFL-K33-1998-0015)

Facility personnel found an interconnecting pipe header pressure gauge that read 3.25 psig, indicating the possibility that gas is inside the tanks. Although operations personnel told facility personnel that these tanks had been purged with inert gas when the gaseous diffusion process was shut down, no records are immediately available to document that condition. Investigators believe that the tanks have been in their current configuration inside the surge volume tank room since approximately 1985. Facility personnel determined that this condition represents a potential unreviewed safety question because the existing facility authorization basis does not consider these quantities of chlorine trifluoride or fluorine could exist. Facility personnel prepared a plan to sample the tanks, so the tank's atmosphere can be analyzed. They also prepared plans to (1) establish continuous air monitoring around the tanks until their contents can be established, (2) develop a method to validate the system pressure, system contents, and valve positions, and (3) perform walk-downs of the associated system piping to establish a firm understanding of the current system configuration. Facility personnel have completed the following actions.

- Secured the surge volume tank room to prevent workers who do not have the proper authorization, personal protective equipment, or monitoring instruments from entering.

- Determined that no detectable readings of hydrogen fluoride were present in the surge volume tank room. (Hydrogen fluoride is the by-product of chlorine trifluoride or fluorine reacting with moisture in the atmosphere.)

- Visually inspected the condition of the tanks, pipe header, and valves and determined that they were in stable and good condition. However, facility personnel could not determine the position of the pipe header valves by visual inspection.

- Contacted personnel who were involved in the shutdown of the facility to determine what documentation is available to establish the configuration/condition of the system. Although all personnel contacted believed the system was purged when the gaseous diffusion process was shut down, no records or specific memories of the purging of these tanks are available.

- Notified the appropriate facility management, safety, and emergency preparedness personnel of the potential content of the tanks in order to develop contingency plans if it is determined that the tanks do contain chlorine trifluoride or fluorine.

- Performed preliminary calculations to determine the potential amounts of chlorine trifluoride or fluorine present in the tanks and determined that there could be as much as 1,268 lb of chlorine trifluoride and 782 lb of fluorine.

Facility personnel suspended all planning activities for decontamination and decommissioning of the surge tanks until the contents can be verified. They will continue to review this event and determine if additional compensatory actions are necessary.

NFS has reported appropriate hazard identification techniques in several Weekly Summaries. Specifically, Weekly Summary 98-37 reported a good hazard identification practice at Sandia National Laboratory–California Site, where movers and Environment, Safety, and Health (ES&H) personnel identified two jars of picric acid while performing a walk-down to identify laboratory hazards. The facility manager formed a safety engineering team to determine the appropriate course of action. The team reviewed previous lessons learned and determined that the county Sheriff Department's explosive ordnance disposal team was the appropriate organization to dispose of the acid. On September 4, the explosive ordnance disposal team safely retrieved and disposed of the picric acid. (ORPS Report ALO-KO-SNL-CASITE-1998-0008)

These events illustrate the need for managers to ensure that integrated safety management systems are effectively implemented. The objective of integrated safety management programs is to incorporate safety into management and work practices by addressing all types of work and all types of hazards to ensure safety for workers, the public, and the environment. In this event, facility personnel quickly identified the potential hazards. Personnel involved in this event were also prepared to encounter unidentified hazards, and they successfully used lessons learned to avoid a potential event. In the East Tennessee Technology Park event, management's commitment to using the integrated safety management approach in decommissioning activities may have prevented a chlorine trifluoride or fluorine release that would have resulted in an immediately dangerous to life and health environment.

These events also highlight the need for managers to develop appropriate programs and procedures to enable personnel to handle chemicals safely. These programs should address safe handling, storage, disposal, and transportation requirements for chemicals. Facility managers should also ensure that workers are familiar with facility safety precautions and emergency procedures. Hazardous chemicals must be identified and their risks understood. Risks should be evaluated, and barriers should be put in place to reduce them. Facility managers should emphasize the importance of researching all available sources of chemical safety information. Chemical data on chlorine fluoride and fluorine may be found in the National Institute for Occupational Safety and Health (NIOSH) *Pocket Guide to Chemical Hazards*.

Facility managers should review the following documents for additional information on safety management systems and hazardous chemicals.

- DOE G 450.4-1, *Integrated Safety Management System Guide for Use with DOE P 450.4, Safety Management System Policy, and DEAR Safety Management System Contract Clauses*, describes the principles and functions that must be addressed in an effective integrated safety management program.

- DOE-STD-1120-98, *Integration of Environment, Safety, and Health into Facility Disposition Activities*, provides guidance for enhancing worker, public, and environmental safety. This standard supports integrated safety management system principles to guide the safe accomplishment of work activities, which include (1) line management responsibility for safety, (2) clear roles and responsibilities, (3) competence commensurate with responsibilities, (4) balanced priorities, (5) identification of safety standards and requirements, (6) hazard controls tailored to work being performed, and (7) operations authorization.

- 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*, states that hazard barriers and controls must be designed, implemented, and validated before initiating chemical processes. The regulation also states that these barriers and controls should be reviewed periodically and updated as necessary.

Integrated safety management information can be found on the Safety Management website at http://tis-nt.eh.doe.gov/ism. Information about chemicals, chemical hazards, and chemical safety programs can be found on the DOE Office of Environment, Safety and Health, Office of Worker Safety, Chemical Safety Program website at http://tis-hq.eh.doe.gov/web/chem_safety. NIOSH documents can be obtained by calling (800) 356-4674 or writing to NIOSH Publications, 4676 Columbia Parkway, Cincinnati, OH 45226-1998.

**KEYWORDS:** chemical, hazard analysis

**FUNCTIONAL AREA:** Chemical Safety, Integrated Safety Management, Industrial Safety

## 4. TAMPER SWITCH FAILS TO DETECT FIRE PROTECTION SYSTEM VALVE MISALIGNMENT

On December 10, 1998, at the Savannah River Tritium Facility, personnel conducting annual fire protection tests discovered two normally open sprinkler system shutoff valves in the closed position. Tamper switches on the valves did not send supervisory alarm signals to a fire protection panel as they should have to indicate the valves were not fully open. Facility personnel are unable to determine how long the valves have been in this condition. This occurrence is significant because the misaligned valves would have prevented fire safety systems from responding to a fire. (ORPS Report SR--WSRC-TRIT-1998-0019)

A tamper switch is a microswitch whose actuator, usually a sensing rod or roller, rests on the diameter of a valve stem. It is adjusted so that its actuator drops into a notch or groove machined into the valve stem when the valve is at the monitored position, which is normally the fully open position. The switch activates a supervisory alarm when the valve leaves the monitored position.

The misaligned valves supply sprinkler systems for areas containing tritium processing equipment. Because of concerns about the formation of oxides of tritium by contact with water, the systems were initially operated as dry-pipe manual pre-action systems. Responders to a fire would open the shutoff valves to supply water to the systems. At that time, the valves were monitored by tamper switches that generated supervisory alarms if they left the closed position. Engineers later converted the systems to wet-pipe systems, which requires the shutoff valves to be open. However, constructors did not modify the tamper switches and valves to monitor the open position.

The misaligned valves are located above a false ceiling. All that is visible from below the ceiling is the operating chains for the valve hand wheels. The normal method of checking that a valve is open is to close it approximately a quarter-turn and then reopen it. The same procedure is used to check tamper switch function. Depending on the orientation of a concealed valve and the orientation of the person operating the valve, closing it slightly and opening it slightly have the same “feel.” Investigators believe that operating personnel have been checking these valves from the closed position for an indeterminate period, while they thought they were checking them from the open position. The error is more likely to occur if an operator assumes that the valves are open to begin with. Facility procedures did not require visual verification of the positions of the valves.

OEAF engineers reviewed the ORPS database for occurrences involving fire protection system tamper switches and identified the following instances in which tamper switches did not accurately report shutoff valve status.

- At the Savannah River Balance-of-Plant Facility, fire protection engineers discovered a closed deluge system shutoff valve during an inspection of the system. The tamper switch for the valve did not send a supervisory alarm to the site fire alarm system as it should have. Investigators determined that the misaligned valve was one of two shutoff valves that fire protection personnel had closed two days earlier during recovery from an inadvertent activation of a dry-pipe deluge system. Personnel had not reopened the valve during system realignment although it was listed on an impairment report. Engineers inspected the valve and discovered that the tamper switch sensing rod was resting between threads on the valve stem, simulating an open condition. (ORPS Report SR--WSRC-FIRE-1997-0003)

- At the Idaho National Engineering Laboratory Fuel Conditioning Facility, the fire department received a supervisory alarm for a sprinkler system shutoff valve. Upon investigation, fire protection personnel discovered that a technician had accidentally bumped the tamper switch for the valve while he was installing pipe and valve labels. They also discovered that the valve was closed instead of open. Investigators believe that personnel recovering from an inadvertent activation of the sprinkler system approximately four months earlier failed to reopen the valve during restoration operations. The tamper switch had not generated an alarm at the fire supervisory panel. Fire protection engineers inspected the valve and determined that lack of structural rigidity in mounting hardware had allowed the tamper switch to shift out of position. (ORPS Report CH-AA-ANLW-FCF-1994-0023)

These occurrences underscore the importance of maintaining positive control over the position of critical valves in fire suppression systems. Misalignment of a fire suppression system threatens human safety, equipment, and processes. Facility and process safety analyses frequently take credit for the ability of these systems to limit the release of radioactive materials or hazardous materials under fire conditions. In particular, these events demonstrate that system operators cannot rely upon tamper switches to provide positive indication of valve positions. Facility managers should consider the following measures to assure the integrity of fire suppression systems.

- Perform a one-time inspection of all critical fire suppression system valves to verify their positions and the operability of tamper switches.
- Revise procedures to require visual verification of valve positions during alignment checks.
- Perform periodic walk-downs of fire suppression systems to verify the status of critical valves. If necessary, add status checks to operator rounds sheets.
- Revise surveillance programs to include periodic checks of the operability of tamper switches.
- Revise maintenance procedures to require complete lineup checks before restoring fire suppression systems to service following maintenance or testing.
- Whenever possible, incorporate water flow checks into sprinkler system test and restoration procedures.

National Fire Protection Association Standards NFPA 13HB-96, *Automatic Sprinkler System Handbook*, and NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, provide valuable guidance for designing and maintaining water-based fire suppression systems. A catalog of NFPA standards is available on the web at http://www.cssinfo.com/info/nfpa.html.

**KEYWORDS:** configuration control, fire suppression, switch, valve

**FUNCTIONAL AREAS:** Configuration Control, Fire Protection, Operations

## 5. INADEQUATE EMERGENCY RESPONSE TO EXPERIMENT MISHAP

On November 25, 1998, at the Pacific Northwest National Laboratory, a researcher was conducting an experiment in a fume hood when a vessel ruptured and expelled a mixture of 130 degrees centigrade trichloroethylene, hydrogen peroxide, and soil approximately 8 feet from the face of the fume hood. The vessel ruptured while the researcher was momentarily outside of the laboratory. When the researcher returned and discovered the mishap, he shut off the equipment and vacated the laboratory to an adjacent space where he could observe the laboratory through a window. Although he knew there was a potential for fire, he did not immediately notify his manager or emergency response personnel. The researcher did stay in the vicinity for approximately 1 hour to observe that there were no further reactions and that no fires resulted. Inadequate researcher response to laboratory emergencies can result in delayed emergency response or uncontrolled release of hazardous materials to the environment. (ORPS Report RL--PHMC-PNNLBOPER-1998-0022)

Investigators have not determined the cause of the vessel rupture. Figure 5-1 shows the fume hood and the ruptured vessel. Investigators determined that the experiment had been running for several hours without incident when the researcher left the laboratory. They also determined that approximately 1 liter of material was expelled from the ruptured vessel. Investigators are assessing recorded experimental data and obtaining specifications from the vessel supplier to determine the probable root causes of the rupture. The facility manager is considering long-term corrective actions that include defining what an emergency mishap or upset condition is, establishing an emergency notification chain, and establishing and communicating hazard response expectations to experimenters.

**Figure 5-1. Fume Hood and Ruptured Vessel**

NFS reported a similar event involving an inadequate emergency response in Weekly Summary 98-25. A shift superintendent at the Rocky Flats Environmental Technology Liquid Waste Treatment Facility declared an operational emergency alert when facility personnel discovered approximately 2 gallons of radioactive phosphoric acid that had spilled from a tank into a bermed area. He directed emergency operations personnel to secure the area; shelter employees; establish eating, drinking, and smoking restrictions; and sample the liquid. Investigators determined that facility personnel waited approximately 15 to 30 minutes before they reported the spill. They also determined that (1) personnel in the spill area did not observe the eating or drinking restrictions after emergency operations personnel made the announcement and (2) some workers who assisted emergency operations personnel were not wearing personal protective equipment. Investigators also determined that the tank had been in a high-level alarm condition since at least 1991 and it may have spilled before. Facility personnel were not sufficiently trained to recognize a spill, properly report it, or respond to it. (ORPS Report RFO--KHLL-LIQWASTE-1998-0002)

These events underscore the importance of having adequate emergency response plans and adequately training personnel to use them. Facility safety precautions and emergency procedures should provide workers with the necessary information to ensure proper response to the emergency.

Facility managers should review the following for additional information on chemical safety and good laboratory practices regarding emergency response to experimental mishaps.

- 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, provides direction on the use of chemicals, including signs and labels; spills and accidents; basic rules and procedures; and training and information. It is available from OSHA at http://www.osha-slc.gov/OshStd_data.

- National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* 1995, section 2.D, "Institutional Policies and Emergency Response Planning," provides information for laboratory managers to use in developing emergency response plans and training. Information on how to order this book can be obtained from the National Academy Press, 2101 Constitution Ave., N.W., Washington, D.C. 20418, (202) 334-3313.

Additional chemical safety references can be found at the DOE Chemical Safety Program website at http://tis.eh.doe.gov:80/web/chem_safety/.

**KEYWORDS:** chemicals, emergency

**FUNCTIONAL AREAS:** Chemistry, Industrial Safety

## 6. WORK PERFORMED ON CONTAMINATED EQUIPMENT WITHOUT RADIOLOGICAL SURVEYS

On December 4, 1998, at the Fernald Environmental Management Project, two electricians de-energized and disconnected a power hacksaw that was internally contaminated, resulting in the contamination of work gloves. The maintenance work order for the job required the electricians to contact radiological control technicians 48 hours before starting the work, but they failed to do this. On December 5, while exiting a radiological control point, one of the electricians set off a personnel contamination alarm. He had in his pocket his work gloves, which he had stored in his toolbox after he used them to work on the saw the day before. Oily material was visible on the gloves. A radiological control technician surveyed the gloves and found 25,000 dpm/100 $cm^2$ beta-gamma on the palm of the right glove and 2,000 dpm/100 $cm^2$ beta-gamma on the palm of the left glove. The failure to follow the requirements of the work order meant that the electricians had no radiological control support. A pre-job survey would have identified the contamination, and a job-specific radiological work permit would have been prepared specifying the use of appropriate personal protective equipment. (ORPS Report OH-FN-FDF-FEMP-1998-0030)

The electricians had been assigned to disconnect the electrical supply to the hacksaw in order to move it from the millwright shop to another building. The work involved (1) disconnecting wires inside a control box on the side of the saw, which had been used during the preceding week and had oily material on most of its exterior surfaces, and (2) cutting the conduit coming up through the floor to the control box. A survey by a radiological control technician of the power hacksaw found 60,000 dpm/100 $cm^2$ beta-gamma removable on the inside of the lid of the control box and 40,000 dpm/100 $cm^2$ beta-gamma removable on the inside of the box. Surveys of the general work area and the path traveled by the electricians showed no spread of contamination. A survey of the electrician's toolbox found 1,200 dpm/100 $cm^2$ beta-gamma on a pair of pliers used on the control box.

Radiological control technicians posted the saw as a contamination area and labeled the control box, "Caution, Radioactive Material." They also decontaminated the pliers and the toolbox. They surveyed a reciprocating saw that had been used by the electricians to cut the conduit leading to the control box and found no detectable contamination.

Investigators determined that the maintenance work order for the job did not call for a radiological work permit and radiological control personnel did not perform a walk-down when preparing the work order. However, the work order did require notifying a radiological control technician 48 hours before starting the job. There is no evidence at this time that such notification was received. A label on the frame of the saw stated "Internal Contamination," but there was no label on the electrical control box that the electricians worked in.

OEAF engineers reviewed another similar event this week that occurred at the Oak Ridge National Laboratory. On December 14, 1998, an operator contaminated a leather work glove while removing equipment from a room at the Metals and Ceramics Facility. The contamination on the glove measured 12,000 dpm/100 $cm^2$ beta-gamma. No radiological work permit had been specified for the work because the room was not a contamination or radiation area. Because there was no permit, no personal protective equipment was required. (ORPS Report ORO--ORNL-X10METCER-1998-0010)

NFS has reported events in several Weekly Summaries where radiological coverage was required but not used. Following are some examples.

- Weekly Summary 98-38 reported that two workers at the Oak Ridge Environmental Restoration Facility entered a radiation/contamination area without using the appropriate radiation work permit. The permit would have required the workers to have health physics coverage. A radiological control technician surveyed the workers and found alpha contamination on one worker's shoes and removable alpha contamination on the floor immediately outside the contamination area. (ORPS Report ORO--BJC-X10ENVRES-1998-0012)

- Weekly Summary 98-14 reported that a worker at the Los Alamos National Laboratory Accelerator Complex completed a project without having read and followed radiation work permit requirements. The permit required the worker to contact radiological control personnel to (1) provide continuous radiological coverage; (2) perform job-specific air sampling; (3) establish a radiological buffer area; and (4) perform radiological surveys for personnel, equipment, and tools when the job was completed. Fortunately, there was no spread of contamination. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1998-0004)

- Weekly Summary 97-20 reported that construction workers at Sandia National Laboratory entered a radiological soil contamination area to excavate for the installation of traffic bollards. The workers failed to contact Radiation Protection Operations staff before entering and to have health physics coverage if excavating deeper than 6 inches. (ORPS Report ALO-KO-SNL-NMFAC-1997-0005)

These events illustrate the importance of following the requirements in work plans, work orders, and radiological work permits that specify radiological coverage. If job supervisors address these requirements during pre-job briefings, workers will understand that supporting organizations need to be contacted and may need to be present at the work location.

Managers should ensure that work control processes are followed and radiological protection practices are enforced. They should also ensure that all work-related hazards are evaluated to reduce worker exposure to hazards and to prevent injury. DOE 4330.4B, *Maintenance Management Program*, section 8.3.2, provides guidance on work requests and the need to address personnel safety and radiation protection requirements and permits for performing work. DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities*, provides information on work controls and coordination. Section 3.4.2 describes the planning process and includes requirements for radiation permits.

DOE/EH-0256T, *Radiological Control Manual*, provides guidance on planning and performing radiological work. The radiological work permit is an administrative mechanism used to establish radiological controls for work activities. The responsibility for ensuring adequate planning and control of work activities resides with line management. Managers should ensure that work control processes are followed and all possible contamination mechanisms are evaluated. Section 341, "Radiological Work Controls," states that radiological work activities shall be conducted as specified by the controlling technical work document and radiological work permit. Article 324, "Pre-Job Briefing," states that pre-job briefings should include radiological conditions that prevail in the workplace, special radiological control requirements, and radiological limiting conditions.

**KEYWORDS:** internal contamination, personal protective equipment, radiation protection

**FUNCTIONAL AREAS:** Radiation Protection, Work Planning

## 7. BOX OF INFECTIOUS WASTE MISTAKEN TO CONTAIN RECYCLED LIGHTBULBS

On December 1, 1998, at the Los Alamos National Laboratory, an environmental scientist discovered a sealed bag of infectious waste inside a box that was believed to contain incandescent lightbulbs for recycling. The infectious waste consisted of blood-soaked cloths inside an orange biohazard bag and blood that had dripped into a clear plastic bag of room trash. The box of infectious waste, which was found at a recycling facility, originated from the Chemistry and Metallurgy Research (CMR) facility and had initially been incorrectly stored in a less-than-90-day storage area at CMR. The box had orange biohazard labels on each side, a radioactive material, low suspect activity (LSA) label, and an attached Health Physics Radioactive Materials Survey (HPRMS) tag. A relamping crew confused the box of infectious waste with other similar boxes containing recycled bulbs and transported it, along with the rest of the boxes, to the recycling facility. This event is significant because personnel did not recognize or believe the box contained infectious waste even though it was correctly labeled as a biological hazard. (ORPS Report ALO-LA-LANL-CMR-1998-0043)

On July 24, 1998, while treating a cut on a mechanic's hand inside a radiological buffer area at CMR, radiation control technicians (RCTs) had allowed blood to drip into a 2 cubic foot, plastic-lined, cardboard, LSA box that was three-quarters full of general room trash. They sealed the plastic liner and pushed it down into the box. They then placed some blood-soaked cloths and other trash in a sealed orange biohazard bag and placed the bag on top of the trash in the box. The biohazard bag was labeled "Caution - Infectious Waste". They sealed the box and placed orange biohazard labels on all four sides of the box.

On September 2, an RCT surveyed the box for release and attached an HPRMS and an LSA label to it. Waste Management and Environmental Group personnel moved the box to a less-than-90-day storage area in CMR even though it was not RCRA waste and was not listed on the waste inventory for the room. On September 29, a relamping crew transported 10 boxes, all of which were thought to contain used bulbs (classified as hazardous waste), from the CMR storage area to the recycling facility. There were seven boxes of fluorescent bulbs (containing mercury) and three boxes assumed to be incandescent bulbs (containing lead). The incandescent bulbs were packed in the same type of 2 cubic foot cardboard box as the infectious waste.

On November 10, while preparing to transfer boxes of bulbs from the recycling facility to a recycling vendor, a Solid Waste Operations worker noticed the biohazard labels on one of the boxes. He notified the Task Manager for the recycling facility and they decided not to include it in the shipment. In addition to the biohazard labels, the LSA label, and the HPRMS tag, the box now had a Hazardous Waste label with an accumulation start date for less than 90-day storage. The Task Manager and the Solid Waste Operations worker confused the HPRMS tag with a Health Physics Release (HPR) tag used to release noncontaminated items from radiological areas, so neither one considered radiation to be a concern.

The Task Manager discussed the box with some relampers, and they concluded that it was probable an empty biohazard box that had been used to package incandescent bulbs for recycle. The Task Manager also discussed the box with an environmental engineer familiar with biohazards. Because they did not know if the box had been used for biohazards, they had a concern about possible contamination. They concluded that the bulbs (or the bag they were in) could be satisfactorily decontaminated with bleach as a disinfectant.

On November 12, the Task Manager placed hazardous waste transportation labels over the biohazard labels that were on the box. On November 16, he wrote a detailed task description for an environmental scientist to disinfect and repackage the bulbs into a new box. On December 1, the scientist opened the box and saw the bright orange biohazard bag and the caution label. He recognized the bag as a biohazard bag and immediately closed the box and stopped the job. The next day, RCTs surveyed the exterior of the box and the storage area and did not detect any contamination.

NFS reported in Weekly Summary 98-11 an event at the Lawrence Livermore National Laboratory, where workers received curium uptakes and spread contamination when they shredded a High Efficiency Particulate Air filter that contained 100 mCi of curium. Investigators determined that the waste was incorrectly characterized on the filter waste storage box label and on a radioactive waste disposal requisition form. They also determined that no one had confirmed the label accuracy or performed radiological surveys or further characterized the filter before it was shredded. (NTS Report NTS-SAN--LLNL-LLNL-1997-0001; ORPS Report SAN--LLNL-LLNL-1997-0038; DOE/OAK-540, Rev. 0, "Type B Accident Investigation Board Report of the July 2, 1997, Curium Intake by Shredder Operator at Building 513 Lawrence Livermore National Laboratory, Livermore, California,")

The Los Alamos event illustrates the importance of a conservative approach, that is, believing labels until they are proven to no longer be valid. The box of infectious waste had been correctly labeled, although the correct labels were later covered by hazardous waste transportation labels. It was handled on numerous occasions between July and November, but no one paid attention to the labeling or attempted to contact personnel at the facility where the box came from in order to determine if it actually contained a biological hazard. The HPRMS tag on the box identified where it came from and the contents could have been verified. Fortunately, personnel finally noticed the labeling before the box had been released to the recycling vendor, but even then they believed it contained lightbulbs. It is also important that personnel take care to correctly label hazardous materials and to package them in containers that cannot be confused with containers commonly used to hold something else.

**KEYWORDS:** hazardous material, labeling, packaging, radiation protection, waste

**FUNCTIONAL AREAS:** Materials Handling/Storage, Radiation Protection, Transportation and Packaging